SASKATCHEWAN RESEARCH COUNCIL

TP 4752E

UPGRADING OF FACILITIES OF THE SLURRY PIPELINE DEVELOPMENT CENTRE AT SASKATOON - PHASES I AND II

Prepared for the Transportation Development Centre

by

D.H. Filson
W.H.W. Husband

May, 1983

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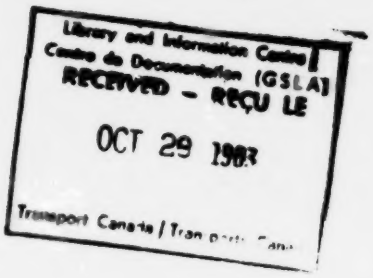
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SRC Publication No. R-725-3-C-83

Saskatchewan Research Council

The contents of this report reflect the views of the contractor and not necessarily the offical views or policies of the Transportation Development Centre.

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17. Abstract

A study was conducted by the Saskatchewan Research Council to determine the equipment required, its arrangement and installed cost, for upgrading the Slurry Pipeline Development Centre at Saskatoon. Coal crushing, grinding, and materials handling equipment as well as a better method of filling pipeline test loops would be needed. Installation of the proposed equipment has been estimated to cost $284,000 (1983).

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17. Résumé

Une étude faite par la Saskatchewan Research Council a permis de déterminer les équipements nécessaires à la modernisation de ses installations pour le transport du charbon par conduites à Saskatoon, ainsi que leur agencement et leur coût d'installation. Cette étude recommande des équipements pour le broyage du charbon brut et la manutention du charbon traité, et suggère une méthode pour le remplissage des conduites de la boucle d'essai plus efficace que la méthode actuelle. Le devis estimatif correspondant à l'installation de ces équipements s'élève à 284,000 $ de 1983.

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SUMMARY

On January 4, 1983 the Saskatchewan Research Council was awarded a contract by the Department of Supply and Services on behalf of the Transportation Development Centre to determine the installed cost of equipment required to upgrade the facilities of the Slurry Pipeline Development Centre at Saskatoon. One purpose of the study was to determine the equipment needed for preparing and handling coal samples received for pipeline tests. A second purpose was to find a better method of introducing coal into the pipeline test loops. The present system causes particle degradation when the loops are being filled with coal, because the slurry passes through the pump during this operation.

Equipment required to receive, prepare and handle truck loads of coal samples is proposed as well as an improved method of filling the pipeline loops. The arrangement and installation of typical equipment is shown in mechanical drawings. Installed equipment costs are given. The total expenditure required to install the proposed equipment is $284,000.

RESUME

Le 4 janvier 1983, le ministère des Approvisionnements et Services, agissant au nom du Centre de développement des transports, a adjugé à la Saskatchewan Research Council un marché pour la détermination du coût d'installation des équipements nécessaires à la modernisation de ses installations pour le transport du charbon par conduites à Saskatoon. Le premier objectif visé par l'étude a été de déterminer les équipements nécessaires pour le traitement et la manutention des échantillons de charbon devant alimenter les conduites formant boucles d'essai. Le deuxième objectif visait à trouver une méthode plus efficace pour introduire le charbon dans les dites boucles; en effet, la méthode actuelle dégrade les fragments de charbon parce que le fluide dans lequel ils sont en suspension les entraîne à travers la pompe.

L'étude propose des équipements pour la réception, le traitement et la manutention des échantillons de charbon arrivés par camions, et suggère une méthode améliorée pour le remplissage des boucles. Des plans sont fournis montrant la disposition des équipements installés, accompagnés d'un devis estimatif s'élevant à 284,000 $.

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1. INTRODUCTION

Pipeline transportation of coal has been developed to the point where there are coal pipelines operating in the USSR, France, Germany and the United States. The potential to transport solids such as coal through pipelines appears so favourable that the term "freight" pipelines is being used. Coal is mixed with an equal weight of water, the resulting slurry is pumped through pipelines as long as 450 kilometres, and then the coal is separated from the water for subsequent use. At least four extremely large coal pipelines are being planned in the United States to move coal over distances as great as 1,500 kilometres. Economic studies have estimated that the cost of pipeline transportation of coal can be as low as half that of rail transport.

The Saskatchewan Research Council has had an active part in coal pipeline development around the world. Experimental pipeline test loops have been operated at Saskatoon since 1961. Much of the work involved coal. Test pipelines as large as 500 mm in diameter have been constructed. The current staff and Professor Shook of the University of Saskatchewan are recognized internationally as an outstanding team in the field of pipeline transport of solids. This team is the basis for Canada being designated the lead agency (through CANMET) for two tasks, i) coarse coal slurry transport, and ii) instrumentation on coal pipelines, by the International Energy Agency.

The facilities of the Slurry Pipeline Development Centre at Saskatoon are limited by the lack of adequate crushing, grinding, sizing, and materials handling equipment. Staff have had to rely on the individual coal companies to obtain specified size consists. This reliance has proved to be impossible. Only run-of-mine coal can be obtained satisfactorily. Thus, there is little or no control over the particle size distribution of the coal at the beginning of a pipeline test. Attempts to have commercial test facilities elsewhere in western Canada prepare coal to specified particle size distributions have failed because of similar reasons.

The facilities of the Slurry Pipeline Development Centre are limited also because the system of filling the pipeline test loops is inadequate for coal. Under the present system, a pipeline test loop is filled with water. Then coal is transferred manually from a hopper into the circulating stream of water until the required concentration of coal in the water is obtained. This procedure takes 20 to 30 minutes and so the coal introduced to the system at the beginning of the filling cycle will have passed through the pump 20 to 30 times before the actual pipeline test

begins. Some Canadian coals are very friable. Although samples are withdrawn from the pipeline test loop after the filling procedure for particle size determination so that the particle size distribution at the beginning of a pipeline test run is known, it is a hit or miss situation as to whether or not this particle size distribution is the precise one required for the test.

In January of 1983 the Transportation Development Centre (TDC) awarded the Saskatchewan Research Council (SRC) a contract to develop plans for overcoming the current limitations of the Slurry Pipeline Development Centre. The first two phases of the contract consisted of determining the additional equipment required and an estimate of its installed costs. After studying the requirements and various ways of overcoming the limitations, SRC retained a consulting engineering firm, Cambrian Engineering, to prepare equipment layouts, assist in preparing specifications, and estimate the installed costs of the recommended alterations and additions to the facilities. This report outlines the recommended changes and summarizes the estimated costs. The engineering details and cost estimates are available in two reports prepared by Cambrian Engineering:

1. Saskatchewan Research Council Coal Sample Preparation and Handling System, Cambrian Project No. A1587, April 27, 1983.

2. Saskatchewan Research Council Pump Drive Relocation, Cambrian Project No. A15787, April 28, 1983.

2. PROJECT OBJECTIVE

The project objective is to estimate the cost of upgrading the facilities of the Slurry Pipeline Development Centre at Saskatoon through the design of coal sizing circuits, an adequate materials handling system, and a better method of introducing coal into the test loops.

3. PROJECT TASKS

The tasks to be undertaken by the project were outlined in the contract work statement and are listed here for reference.

1) A requirements study was to be undertaken on the crushing, screening, grinding and materials handling equipment needed to upgrade the SRC's Slurry Pipeline Development Centre to meet the expected R & D requirements in this field. Methods of providing the required quantities and particle sizing of coal for the pipeline test loops were to be reviewed and the most appropriate one was to be defined in detail. Also an adequate system of filling the test loops with coal was to be designed.

2) The equipment required for upgrading the facilities was to be selected and its installed cost was to be estimated.

3) A brief report of the findings of these first two phases of the overall project was to be prepared.

4. LOCATION OF THE PROPOSED FACILITIES

There are two locations involved in the proposed design for upgrading the Slurry Pipeline Development Centre. The coal samples would be brought to the desired particle size consist by equipment installed in the SRC multipurpose pilot plant located in the Saskatoon Research Park. Pipeline testing of prepared coal samples would be done at the SRC Slurry Pipeline Development Centre located at 1630 Quebec Avenue. These locations are about 7.0 km apart.

The multipurpose pilot plant has a total area of over 800 m^2. It contains, in addition to the usual pilot plant area and services, a workshop (70 m^2), a storage room (70 m^2), and a grinding room (70 m^2). The grinding room has a modern dust collection system. Attached to the pilot plant is a loading platform. A skid-steer loader is at hand.

The pipeline test loops with pumps, slurry tanks, instrumentation, and auxiliary equipment including a skid-steer loader are located at 1630 Quebec Avenue. The building has an area of 560 m^2.

5. COAL PREPARATION AND HANDLING

5.1 Receiving

Run of mine coal received by truck would be crushed to -50 mm and put into drums by a local firm, Argo Rock. These drums would then be loaded onto a SRC truck. The nominal charge for this operation would be $50 per metric ton, the drums being supplied by SRC. The drums would be off loaded at the SRC multipurpose pilot plant using the Ford CL-40 skid-steer-loader and drum clamp attachment.

5.2 Closed Crushing Circuit

The -50 mm coal would be reduced to either -12 mm, -9 mm, or -6 mm (-12 + 9 mm and -9 + 6 mm could also be produced) by a proposed closed crushing circuit located in the pilot plant. This circuit is described by flowsheet No. 1 on page 7.

5.3 Closed Wet Coal Grinding Circuit

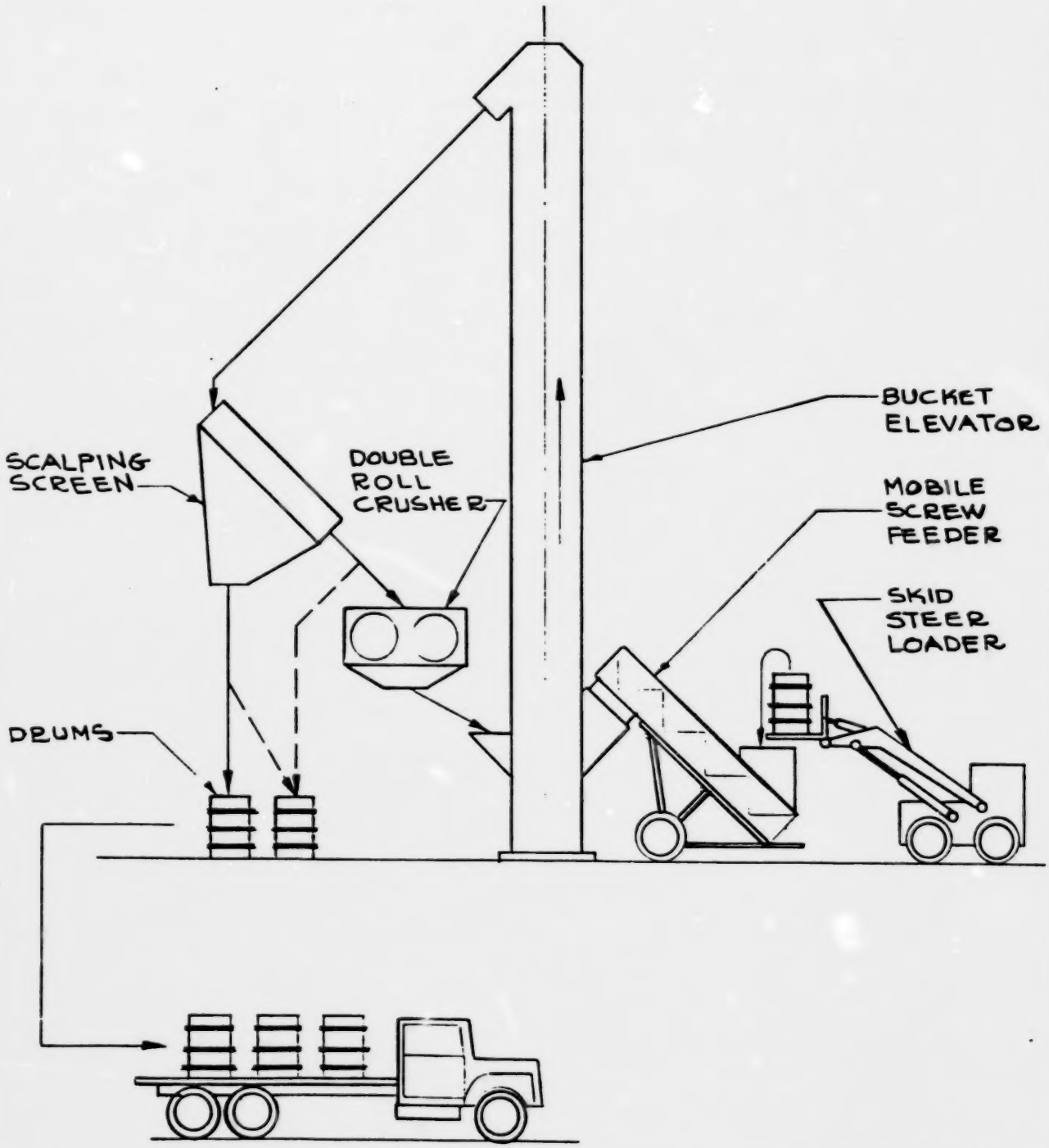
The preparation of -14 mesh coal from crushed coal would be done in a closed wet grinding circuit. Flowsheet No. 2 describing this circuit is shown on page 9. De-watering of the ground coal would be desirable. This operation would require a filter or centrifuge.

5.4 Handling Prepared Coal

Prepared coal whether dry (coarse), in a water slurry, or as a cake would be transported to the Quebec Avenue facility and introduced into one of the pipeline test loops.

The Quebec Avenue facility has a large elevated receiving vessel, extending through the roof of the building which would be used to introduce coal into the pipeline test loops located at ground elevation. It is important to introduce coarse coal into a pipeline test loop without passing through the pump in order to avoid particle degradation. This can be achieved by the method proposed. Coal would be raised to the top of the vessel from outside the building by means of a bucket elevator and a belt conveyor. Dry coal could then be injected into the pipeline loop on the discharge side of the pump. This loading scheme is shown in flowsheet No. 3 on page 10 .

Prepared coal in form of cake would be taken inside the building in drum containers. Each loaded drum would be raised to the top of a



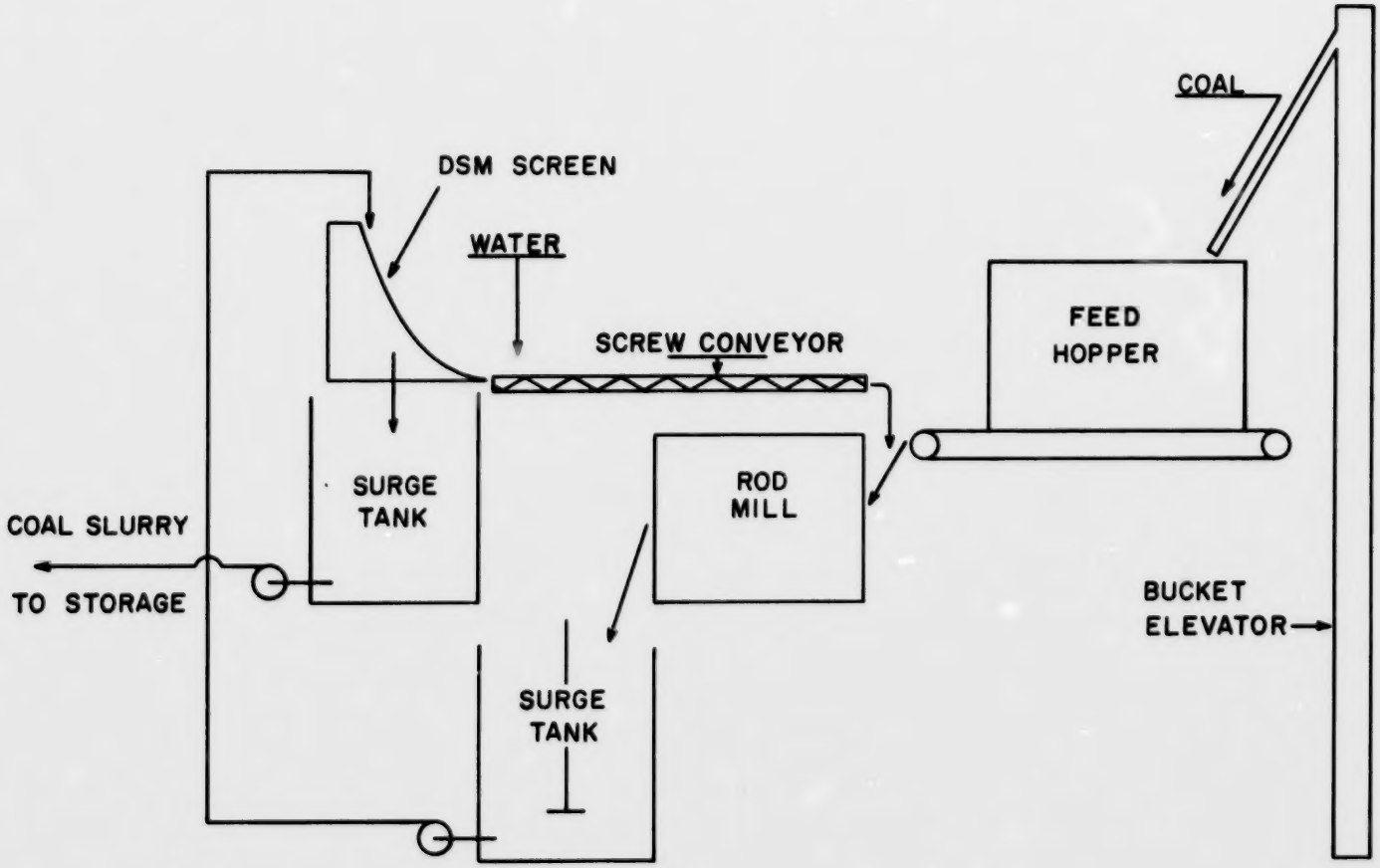
FLOWSHEET Nº 1.

the cambrian group

Client	S.R.C.
Project	PILOT PLANT
Subject	CRUSHING & SCREENING

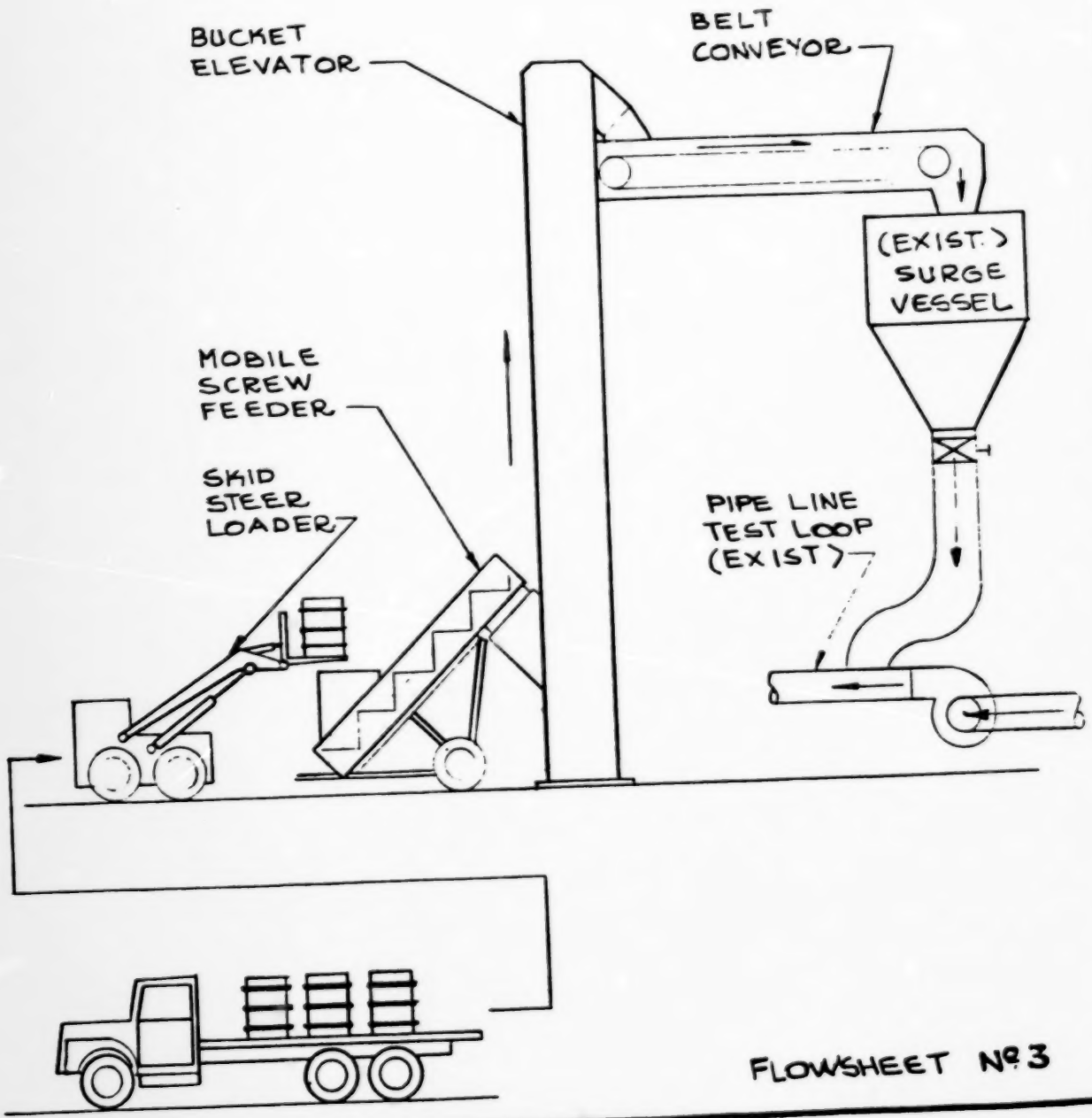
slurry tank with the existing hoist and, by tipping and washing, would have its contents transferred into the tank.

Prepared coal in slurry form would be transported by tank truck and pumped into a slurry tank. Fine coal particles degrade very little on one pass through a pump.



WET COAL GRINDING CIRCUIT

Flowsheet No. 2



FLOWSHEET Nº 3

6. EQUIPMENT SELECTION

6.1 Mobile Equipment

Three major equipment items could be used at either the multipurpose pilot plant or the Quebec Avenue Slurry Pipeline Development Centre facility. These are a barrel tipping device, a mobile screw feeder, and a centrifuge.

6.1.1 Barrel Tipping Device

Drum containers are proposed as a clean and convenient way to handle and transport coal within the city and campus environments. A number of drums are at hand and there is a fork lift loader at each location, a Ford CL-40 at the pilot plant and a Bobcat model 444 at the Quebec Avenue Slurry Pipeline Development Centre. A barrel tipping device which would fit the forks of both of these loaders would be required.

6.1.2 Mobile Screw Feeder

A mobile screw feeder is proposed to feed the bucket elevator at each location. It is needed to reduce the lifting height required of the loaders and to control the feed rate into the elevators. The feed hopper on the screw feeder will permit a full drum to be dumped. The drive unit, supplied with the screw feeder, includes an AC electric motor speed controller. The screw feeder would be mounted on wheels for transport to either location. It can be constructed from standard components. Cambrian Engineering has prepared a detailed drawing of the unit from which it could be manufactured (drawing SR-M3).

6.1.3 Continuous Solid Bowl Centrifuge

A continuous solid bowl centrifuge would be used to dewater coal slurry at either of the two locations.

6.2 Equipment in Multipurpose Pilot Plant

The following equipment items would be installed at the multipurpose pilot plant.

6.2.1 Bucket Elevator

A continuous discharge bucket elevator, 7 metres in height, is proposed for the pilot plant. It would be used for both the crushing and grinding circuits.

6.2.2 Scalping Screen

The screen proposed is a SWECO 760 mm diameter unit complete with feeder and modified surge hopper. This screen would remove fine material before the coal proceeds to the crusher.

6.2.3 Double Roll Crusher

A double roll crusher with 0.3 x 0.46 m corrugated rolls is proposed to crush -50 mm coal. The rolls would be plasma coated for extended wear.

6.2.4 Dust Collection

A dust collection fan and filter unit exists within the sample preparation room. This unit can be connected to the proposed equipment installation by providing 75 mm diameter hose connections to the existing 350 mm collection header. Dust collection points would be at the top of the bucket elevator, at the screw feed hopper, and at the sample collection drums.

6.2.5 Rod Mill 0.61 m x 0.914 m

This is required for wet grinding of crushed coal to -14 mesh.

6.2.6 Pump 38 x 38 mm and 5 H.P. Motor

This pump and driver would pump slurry from the ball mill to the DSM screen.

6.2.7 Pump 76 x 51 mm and 10 H.P. Motor

This pump and driver would pump coal slurry to a storage tank.

6.2.8 DSM Screen

This would remove +14 mesh coal from rod mill slurry.

6.2.9 Screw Conveyor 0.18 m dia. x 3.7 m long

This would return +14 mesh coal to the rod mill.

6.3 Equipment In Quebec Avenue Building

The following equipment items would be installed at the Quebec Avenue Slurry Pipeline Development Centre.

6.3.1 Bucket Elevator

The prepared coal samples must be elevated ten metres above floor elevation (drawing SR-M2). A bucket elevator would do this and may be located outdoors so as not to infringe on the interior building floor space, and yet fit within the property limits. A structural tower has been designed so that the elevator could withstand expected wind loads and provide access to the unit over its entire length (drawing SR-S1). This elevator would also be fed with the mobile screw conveyor.

6.3.2 Belt Conveyor

A belt conveyor is required to convey coal horizontally from the bucket elevator to the roof receiving vessel. The conveyor proposed is a totally enclosed pan trough unit. The mechanical components of the conveyor could be accessed from either end.

7. PUMP DRIVE RELOCATION

The existing drive includes a 250 H.P. motor coupled to a variable filling fluid drive which is connected to the pump shaft by a V-belt drive. This drive is unsatisfactory when conducting tests with the 150 mm test loop. The pump speed can not be reduced sufficiently to achieve the desired operating points. The pump speed must be increased to its maximum (1100 rpm) for the 250 mm test loop runs. The second problem with the existing equipment is the lack of instrumentation. There is no provision for measuring power input to the pump and the speed tachometer is inadequate.

The desired operating speed range for the pump extends from 100 to 1100 rpm. A variable speed AC motor control is the only method available to provide this wide speed variation. A motor control unit which could be purchased for the 250 H.P. motor would be 0.6 m x 1.8 m x 2.3 m high and weigh about 1370 kg. It would be mounted on the mezzanine floor.

A shaft torque transducer would be placed between the motor drive shaft and pump shaft to record the pump speed and input torque. The mechanical design modifications to the pump drive include the relocation of the motor so that a torque transducer can be directly coupled to the pump drive shaft. The relocation involves placing a new concrete inertia pad adjacent to the existing one and installing a new motor base frame. The "Lebow" torque and speed sensing element can then be directly coupled between the motor and pump shafts (drawing No. SR-M5).

8. COST ESTIMATE

A preliminary cost estimate for each location was prepared by Cambrian Engineering to determine the capital requirements for the planned improvements.

The major process component costs are based upon selected supplier quotations which were received by both SRC and Cambrian Engineering. Alternative suppliers could be expected to provide price quotations on similar equipment which would fall within ± 20 percent.

The hourly wage rate used in this estimate is based upon that of a skilled union tradesman receiving full benefits. The productivity used to estimate installation hours is based upon that experienced on unionized construction projects.

The structural fabrication and erection costs are based upon unit costs obtained from recent projects. These projects have involved unionized working sites and therefore reflect union rates for the steel erection, while the supply and facrication costs reflect the past year's average contract price from local fabricators. The total unit cost used to estimate the structural steel therefore represents an average contractor's price using union labor.

The electrical costs estimated for motor connections and cabling are based only on installed motor horsepower. Historically the materials and labor costs have been 60 and 40 percent respectively for similar installations. No provisions have been included for instrumentation or controls. Each piece of equipment would be run independently with no regard to downstream equipment status. Should an interlocking system be desired, additional costs would be required.

8.1 Cost Estimate Breakdown

The costs of the various items required for upgrading the facilities, as estimated by Cambrian Engineering and SRC, are summarized in the following table.

No.	Item	Mtl cost at Saskatoon	Labor at $26/hour	Total Cost
6.1	Fork lift barrel dumper	$ 1,010	$ 210	$ 1,220
6.2	Mobile screw feeder	6,440		6,440
6.3	Centrifuge - 13mm continuous solid bowl and 5 H.P. motor	39,720	1,300	41,020
6.4	Bucket elevator (7m) & motor	7,230	1,820	9,050
6.5	Scalping screen with drive chutes & hopper	9,250	420	9,670
6.6	Roll crusher 0.3 x 0.46 m	20,870	650	21,520
6.7	Dust collection & chutes	850	550	1,400
6.8	Rod mill 0.6 x 0.9 m	24,700	1,300	26,000
6.9	Pump 38 x 38 mm & 5 H.P. motor	3,120	210	3,330
6.10	Pump 76 x 51 mm & 10 H.P. motor	3,470	210	3,680
6.11	DSM screen	5,050	210	5,260
6.12	Screw conveyor & 1 H.P. motor	1,200	210	1,410
6.13	Bucket elevator (11 m) & motor	8,140	1,300	9,440
6.14	Belt conveyor (9 m), motor and chutes	5,300	890	6,190
6.15	Electrical - multipurpose pilot plant	9,800	4,530	14,330
	Electrical - mtl. handling at Quebec Avenue	2,150	1,430	3,580
7.0	Pump Drive Relocation			
	Equipment	4,680	520	5,200
	electrical items	47,200	2,130	49,330
	instruments and controls	8,400	210	8,610
	demolition		520	520
	concrete	290	50	340
	electric wiring	2,500	2,500	5,000
		$211,370	$21,170	$232,540
	Crane rental - 4 hours at $85/hour			340
	Project engineering			4,000
	Total			$236,880

9. CONCLUSION

The cost estimate of $237000 is accurate to within + 20 percent. Therefore one should budget for 1.2 x $237,000 = $284,000 (1983).

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